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Chelone obliqua var. *speciosa* and *Chelone glabra*; article on p. 1. Illustration by Erin O'Connell.

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We are fortunate to feature on the cover of this issue an original watercolor created for the volume by Erin O'Connell of Washington University's Tyson Research Center. I deeply appreciate Erin's time, effort, and artistic abilities in creating a compelling image that highlights one of the issue's articles.

Special thanks as always to Cindy Pessoni of The Nature Conservancy, who, as she has for every issue since Volume 34, assisted with editing and proofing, and led the formatting and design process — *Missouriensis* benefits tremendously from her dedication and talents.

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Major range extension of a *Chelone* population and extirpation of seven populations in Arkansas and Missouri

ALLAN D. NELSON[1], KELLY CARROLL[2], AND MARK NELSON[3]

ABSTRACT. — A range extension for white turtlehead (*Chelone glabra*) is documented for Saline County, Arkansas. We also report the extirpation of two populations of white turtlehead in Greene County, Arkansas and three in Butler County, Missouri. Rose turtlehead (*C. obliqua* var. *speciosa*) is likely extirpated from Arkansas and a population near Poplar Bluff, Missouri has also been extirpated. We update the current status of eight populations of these two species. Both white and rose turtleheads need review in Arkansas and Missouri to determine their conservation status.

INTRODUCTION

We are currently working to update the global conservation status of selected plants with rare or unknown status in NatureServe (2023). Here we report the extirpation of five populations of white turtlehead (*Chelone glabra* L.) and two populations of rose turtlehead (*Chelone obliqua* L. var. *speciosa* Pennell and Wherry) in Arkansas and Missouri. Additionally, we add observations on a population of white turtlehead in Arkansas that represents a major range extension. The five populations of white turtlehead that have been extirpated were previously surveyed by A.D. Nelson in October 1991 (Nelson & Elisens 1999; Nelson 1995). These populations were resurveyed in 2021 and 2022. Observations of the population recently discovered in Saline County in central Arkansas, were conducted in 2005.

ARKANSAS POPULATIONS

Arkansas is the southwestern edge of the distribution for white turtlehead. It is listed as critically imperiled (S1) in Arkansas, which is defined as being a high risk of extirpation due to restricted range, few populations, and severe threats (NatureServe 2023). We conducted fieldwork as a part of a status survey of *Chelone*, which will provide data needed by NatureServe to update populations used in assigning conservation status.

In August 2005, the Arkansas Natural Heritage Commission gave directions to assess a white turtlehead site discovered in 1979 in Saline County, Arkansas. In a posting on iNaturalist, Theo Witsell stated "Wet seep along creek at base of sandy hill. This site represents a southwestern

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range extension for this species of more than 150 miles. The nearest known site is in a seep on Crowley's Ridge in Greene Co., AR" (iNaturalist 2023). We relocated a site in this vicinity of Saline County in a wet ravine leading to a creek near the town of Shaw. Associates at this site include red maple (*Acer rubrum*), American holly (*Ilex opaca*), blunt-lobed cliff fern (*Woodsia obtusa*), and several other fern species. The *Chelone* population consisted of eight stems in three clumps. Plants were in early flower bud and a few were just opening to reveal white corollas. Because of the small size of the population, voucher collections were not made in 2005. The site is listed by Gentry et al. (2013) in their Arkansas state atlas, but is absent in a Green County checklist (Harris et al. 2012).

In October 1991, fieldwork in Greene County, Arkansas revealed two populations of white turtlehead. The first population was at a site locally called Pine Hill Bog and the second at Glory Hole Bog.

On 11 October 1991, Pine Hill Bog had 30 or more plants and about 60 stems. Flowers and fruits were both present and fruits were heavily impacted by green hemipterans. Plants were in rich black loam, growing with upland boneset (*Eupatorium sessiflorum*), peat moss (*Sphagnum* sp.), sedges, and rushes. Sweetgum (*Liquidamber styraciflua*) shaded parts of the population.

The Pine Hill Bog site was revisited on 9 August 2021. The area around the bog had been cleared and the wetland dug out to form a stock watering hole for cattle, which were present at the site. All that remained of the former forest was a tree fringe dominated by post oak (*Quercus stellata*) and shortleaf pine (*Pinus echinata*), which grew along the fence and edge of a cemetery above the former bog site. White turtlehead was not located, and the former habitat was completely altered by the clearing and grazing.

The population at Glory Hole Bog consisted of 15 plants and 30 stems with brown coleopterans entering and exiting flowers. Fruits were not present on 11 October 1991. Plants were in rich black loam, associated with upland boneset, peat moss, cinnamon fern (*Osmunda cinnamomea*), broadleaf cattail (*Typha latifolia*), sedges, and rushes. River birch (*Betula nigra*) was the dominant woody plant near the white turtlehead population.

The Glory Hole Bog site was revisited on 9 August 2021, and no white turtlehead was found. The site exhibited extensive rutting caused by all-terrain vehicles (ATVs), installation of several game feeders, and addition of a ground hunting stand. Another difference was altered hydrology as the broadleaf cattails present in 1991 were absent in 2021. River birch, peat moss, cinnamon fern, sedges, and rushes were still present. A house had been built on the bog's edge and there were relatively large housing developments in the area that were not present in 1991. This new land use of hunting using ATVs and change in hydrology, possibly due to increased residential water usage, likely contributed to the extirpation of white turtlehead in the bog.

Rose turtlehead is known in Arkansas from a single Greene County record from 1893 (pers. comm. Arkansas Natural Heritage Commission 1992). Its conservation status needs to be updated in Arkansas and Missouri as well as other states (NatureServe 2023). The Arkansas population has probably been destroyed and it is not likely to be rediscovered (pers. comm. Arkansas Natural Heritage Commission 1992). It is unlikely that the species is still extant in the state (Smith 1988), but it is listed in the state atlas (Gentry et al. 2013). It was not located during our 1991 and 2021 fieldwork in Greene County.

MISSOURI POPULATIONS

Fieldwork was conducted at three Missouri sites in the Poplar Bluff area (Butler County) in October 1991 and 2022. In 1991, fieldwork documented three populations of white turtlehead and one of rose turtlehead. These were at sites locally called Military Crossing Cemetery, State Forest near Hilliard, and the McLane Subdivision in Poplar Bluff.

On 12 October 1991, the population at Military Crossing Cemetery consisted of 24+ plants and about 50 stems. Flowers and fruits were both present, and fruits had been heavily impacted by green hemipterans. Plants were in rich black loam, growing with upland boneset, bottle gentian (*Gentiana andrewsii*), small-fruited panic grass (*Dichanthelium microcarpon*), sedges, and rushes. Eastern cottonwood (*Populus deltoides*) shaded parts of the population.

The site was revisited on 8 October 2022. The area around the swamp included none of the previously associated species. White turtlehead was not located, and the former habitat was significantly altered by beaver activity and associated hydrological changes. Vegetation was dominated by woolgrass (*Scirpus cyperinsus*) and swamp smartweed (*Persicaria hydropiperoides*) with woody species dominated by American hornbeam (*Carpinus caroliniana*) and buttonbush (*Cephalanthus occidentalis*).

On 12 October 1991, the white turtlehead population at State Forest consisted of 35 plants and 70 stems, with no fruits present. Plants were in rich black loam, growing with upland boneset, bottle gentian, small-fruited panic grass, Canadian lousewort (*Pedicularis canadensis*), and sedges. The area had been partially cleared for electrical lines and had more tree diversity than the cemetery site, including eastern cottonwood, sweetgum, and red maple. A seep from the hillside provided a consistent wetland hydrology.

On 9 October 2022, the State Forest site had extensive rutting caused by ATVs, and none of the former associates were present except some sedges along edges of ATV ruts. Water from the seep filled numerous ATV ruts but did not expand out into the wetland as it had in 1991. This new impact of repeated ATV traffic through the seep and surrounding wetland likely contributed to the extirpation of white turtlehead at this site.

On 12 October 1991, the McLane Subdivision site was along a creek bordering a housing project in Poplar Bluff, Missouri. The wooded creek valley had dark loam with green arrow arum

(*Peltandra virginica*), bottle gentian, Canadian lousewort, and sedges. Red maple was the dominant woody plant near the white turtlehead population. The population consisted of 20 stems from about 10 plants. Deeper into the valley was a population of rose turtlehead consisting of 20 plants with about 30 flowering stems.

During a site visit on 10 October 2022, neither white nor rose turtlehead were found. Associated species seen in 1991 were absent, except for red maple. The subdivision had expanded, and storm drains and underground electrical lines had been installed in the creek valley, destroying the habitat and the turtlehead populations.

In addition to the fieldwork reported above, we used the Texas Oklahoma Regional Consortium of Herbaria (TORCH) portal to examine two imaged specimens of rose turtlehead, both collected by Steyermark in Wayne County, Missouri adjacent to Stanley Creek (APSC 0051300 and GA 220258). ImageJ 1.x (Collins 2007) was used on the two digital images to examine calyx pubescence and leaf characters so that the specimen's varietal determination could be confirmed following Nelson (2019). A.D. Nelson visited parts of Stanley Creek near a roadside to search for rose turtlehead, but the area was privately owned and posted, so only a small area could be examined. From the road, the area looked like potential habitat might still occur but as illustrated for the other sites discussed here, many land use changes may have occurred since Steyermark's visit in the late 1940s.

These data indicate a compelling need to reassess the conservation status of both species in Arkansas and Missouri, as well as throughout their ranges. Recent declines and local extirpations associated with land use changes and other disturbances, including potential climate change effects, may result in continued losses and require intensified conservation efforts.

REPRESENTATIVE SPECIMENS EXAMINED

Chelone glabra. **U.S.A. ARKANSAS**: GREENE CO.: Glory Hole Bog, 11 October 1991, *A.D. Nelson 143* (OKL); Pine Hill Bog, 11 October 1991, *A.D. Nelson 142* (OKL). SALINE CO.: 27 September 2002, *Theo Witsell 1172* (ANHC). **MISSOURI**: BUTLER CO.: Poplar Bluff, McClane Subdivision, 12 October 1991, *A.D. Nelson 146 with S. Hudson* (OKL); Military Crossing Cemetery, 12 October 1991, *A.D. Nelson 144 with S. Hudson* (OKL); State Forest near Hilliard [=Poplar Bluff/Stephen J. Sun Conservation Area], 12 October 1991, *A.D. Nelson 145 with S. Hudson* (OKL).

Chelone obliqua var. *speciosa*. **U.S.A. MISSOURI**: BUTLER CO.: Poplar Bluff, McClane Subdivision, 12 October 1991, *A.D. Nelson 146 with S. Hudson* (OKL).

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Noteworthy plant records in Missouri after a major pipeline construction project

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ABSTRACT. — *Myosotis arvensis* and *Centaurium pulchellum* are reported new to Missouri from the Litzsinger Road Ecology Center in St. Louis County. Three additional species are reported new to St. Louis County: *Sesamum indicum*, *Cyclospermum leptophyllum*, and *Krigia cespitosa*. These records were documented after the completion of a sewer pipeline project. Comparisons between closely resembling species, known distributions, and potential propagule origins are discussed.

INTRODUCTION

Two plants new to Missouri were discovered following construction of a major sewer pipeline at the Litzsinger Road Ecology Center (LREC) in St. Louis County: *Myosotis arvensis* (L.) Hill (Boraginaceae) and *Centaurium pulchellum* (Sw.) Hayek ex Hand.-Mazz., Stadlm., Janch. & Faltis (Gentianaceae). Three additional species at the site are new to St. Louis County: *Sesamum indicum* L. (Pedaliaceae), *Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & Wilson (Apiaceae), and *Krigia cespitosa* (Raf.) K.L. Chambers (Asteraceae).

The newly discovered occurrences come after the initiation of Project Clear, a sewer pipeline project led by the Metropolitan St. Louis Sewer District (MSD). Project construction started at the LREC in September 2019 and ended in August 2022. Prior to Project Clear, the area was predominantly restored bottomland woodland and prairie (Kathriner & Faupel 2022). During construction, the pipeline path was heavily disturbed by large machinery and trenching for pipeline insertion. Further, adjacent Deer Creek holds the potential for flash flooding at high creek levels that temporarily inundate the pipeline path. With a multitude of disturbances during three years of construction, early successional and adventive species covered the pipeline path during its first full year of unmanaged post-construction growth.

METHODS

All records were discovered during surveys of the LREC property and pipeline path from 2020 to 2023. An iNaturalist observation (iNaturalist 2023) was made for all specimens at the time of collection. Herbarium specimens were prepared following the protocol of Bridson and Forman (1998). Specimens were accessioned into the Missouri Botanical Garden herbarium (MO) and are stored offsite at the LREC. Digitized information for specimens discussed in this report are available on Tropicos, the herbarium collections database of the Missouri Botanical Garden

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(Tropicos 2023). Specimens were determined as Missouri or St. Louis County records based on the existence of herbarium specimens in the Southeastern Regional Network of Expertise and Collections (SERNEC), Tropicos, and Research Grade quality iNaturalist observations.

SPECIES ACCOUNTS

Myosotis arvensis

A single individual of *Myosotis arvensis* (field forget-me-not) was discovered on the pipeline path along Deer Creek in June 2023. *Myosotis* L., commonly named forget-me-not or scorpion grass, is a genus of 100 species found in temperate and tropical regions (Winkworth et al. 2002). The genus is characterized by its blue, white, or yellow corolla, unbranched style, single stigma, and laterally compressed mericarps (Al-Shehbaz 1991). Only four *Myosotis* species were previously known to occur in Missouri (Weakley et al. 2023; Yatskievych 2006).

Myosotis arvensis is native to Eurasia but occurs across subarctic Canada and the northern United States and the eastern portion of the Southeastern United States (NatureServe 2023; Weakley et al. 2023). Based on digitized herbarium specimens, the nearest populations to Missouri are from the northeast in Grant County, Wisconsin and a 19th century record from Cook County, Illinois, from the east in Posey County, Indiana, from the south in Shelby County, Tennessee, and from the west in Decatur County, Kansas.

In Missouri, *M. arvensis* is most morphologically similar to *M. stricta* Link *ex* Roem. & Schult.; both species have blue corollas (occasionally with yellow and white) and a calyx with five equal lobes. However, *M. arvensis* has fruiting pedicels that equal or exceed the calyx, whereas *M. stricta* has fruiting pedicels shorter than the calyx (**Figure 1**; Weakley et al. 2023). Both species occur in disturbed areas, so care should be taken when identifying these two species in the field, paying attention to the pedicel length relative to the calyx length.

> *Voucher specimen*: **U.S.A. MISSOURI**: ST. LOUIS CO.: Litzsinger Road Ecology Center, southern section of fallow pipeline path near woodland edge and creek bank, 38.623762°N, 90.37577°W, 12 June 2023, *C.M. Sims CMS1106* (MO).

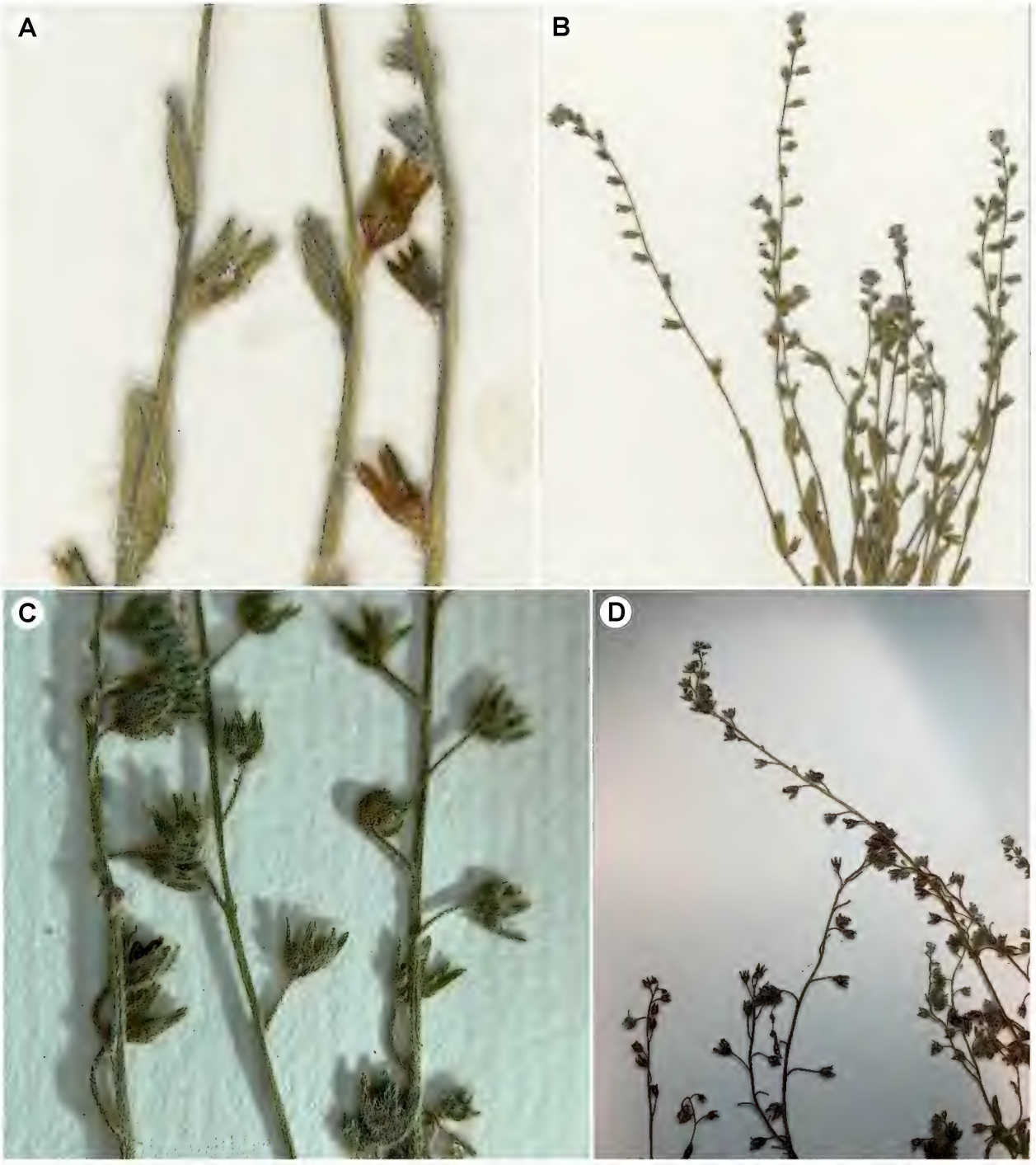

Figure 1. **A**. and **B**. *Myosotis stricta* fruiting pedicel and calyx (*Davidse 40480*, MO). **C**. and **D**. *Myosotis arvensis* fruiting pedicel and calyx (*Sims CMS1106*, MO). Photos: Caitlyn Sims.

Centaurium pulchellum

Three plants of *Centaurium pulchellum* (lesser centaury) occurred on the pipeline path, scattered through a 1.27 ha (3.14 ac) area, on fallow ground and on the edge between the fallow path and woodland. Three species of *Centaurium* occur in the southeastern United States; none have been previously recorded in Missouri (Weakley et al. 2023), although there is a 2020 iNaturalist observation of *C. erythraea* Rafn from Jefferson County (iNaturalist 2023). *Centaurium erythraea* has sessile to subsessile flowers, as opposed to the pedicellate flowers of *C. pulchellum*. A native of Eurasia, *C. pulchellum* occurs across North America, from Washington and California to New York, Massachusetts, and Maine, and from Texas and Louisiana to Canada, Wisconsin, and Michigan (Kartesz 2015; Mansion 2014).

The nearest records to Missouri are in the north from the six northeasternmost counties in Illinois (Wilhelm & Rericha 2017) and digital herbarium records from Rock County, Wisconsin, the east in Shelby County, Indiana, the south in Prairie County, Arkansas, the west in Arapahoe County, Colorado, and the northwest in Antelope County, Nebraska. Kaul et al. (2006) report a specimen from Douglas County, Nebraska.

In Missouri, *C. pulchellum* is morphologically similar to *Zeltnera texensis* (Griseb.) G. Mans. ex J.S. Pringle [=*Centaurium texense* (Griseb.) Fernald]. These two species cannot be confidently differentiated without magnified inspection of the stigma and style (Mansion 2004). The style of *C. pulchellum* is divided just below the stigma surface and the stigma lobes are reniform, while the style of *Z. texensis* is undivided and the stigma lobes are flabelliform (Mansion 2004; McDaniel 2022; Pringle 2023). *Zeltnera* is not yet included in the keys of the *Flora of the Southeastern United States* (Weakley et al. 2023), complicating identification between the two species. However, both genera are treated by Pringle (2023).

Centaurium pulchellum has pedicels shorter than the calyces, 1–5(11) mm long, calyces (3)5–9(11) mm, and broader, elliptic-oblong to lanceolate cauline leaves, 1–5(12) mm broad, (**Figure 2**), whereas *Z. texensis* has pedicels 4–20 mm long, calyces 6–12 mm, and narrowly elliptic to linear leaves, 0.5–4.5(8) mm broad (**Figure 3**; McDaniel 2022; Pringle 2023). Additionally, *C. pulchellum* has occasionally persistent obovate basal leaves, and branching above the middle in small individuals, but at lower nodes in large individuals, whereas *Z. texensis* does not usually have persistent basal leaves and branching begins below the middle (Pringle 2023).

Habitat may further support species identification, because *C. pulchellum* occurs in moist, disturbed habitats, and *Z. texensis* is found in rocky sites or in calcareous soils (Pringle 2023; Yatskievych 2013). *Zeltnera texensis* also has an assigned coefficient of conservatism rank of 9, suggesting that it is not likely to be found in post-construction sites (Ladd & Thomas 2015). Due to the minor differences between *C. pulchellum* and *Z. texensis*, it is likely that *C. pulchellum* has been overlooked in the state. A 2021 iNaturalist observation from Cottleville, Missouri has been suggested as *C. pulchellum*, but identification cannot be confirmed without images of the stigma and style.

Figure 2. *Centaurium pulchellum*. **A**. Flower pedicels (*Fleetwood 10346*, MO). **B**. Lateral view of style and stigma lobes (*Sims, CMS1108*, MO). **C**. Stigma lobes (*Bailey*, *s.n.*, MO1007061). **D**. Style and stigma lobes (*Sims*, *CMS1108*, MO). **E**. Habit (*Sims*, *CMS1108*, MO, from Tropicos). Photos: Caitlyn Sims.

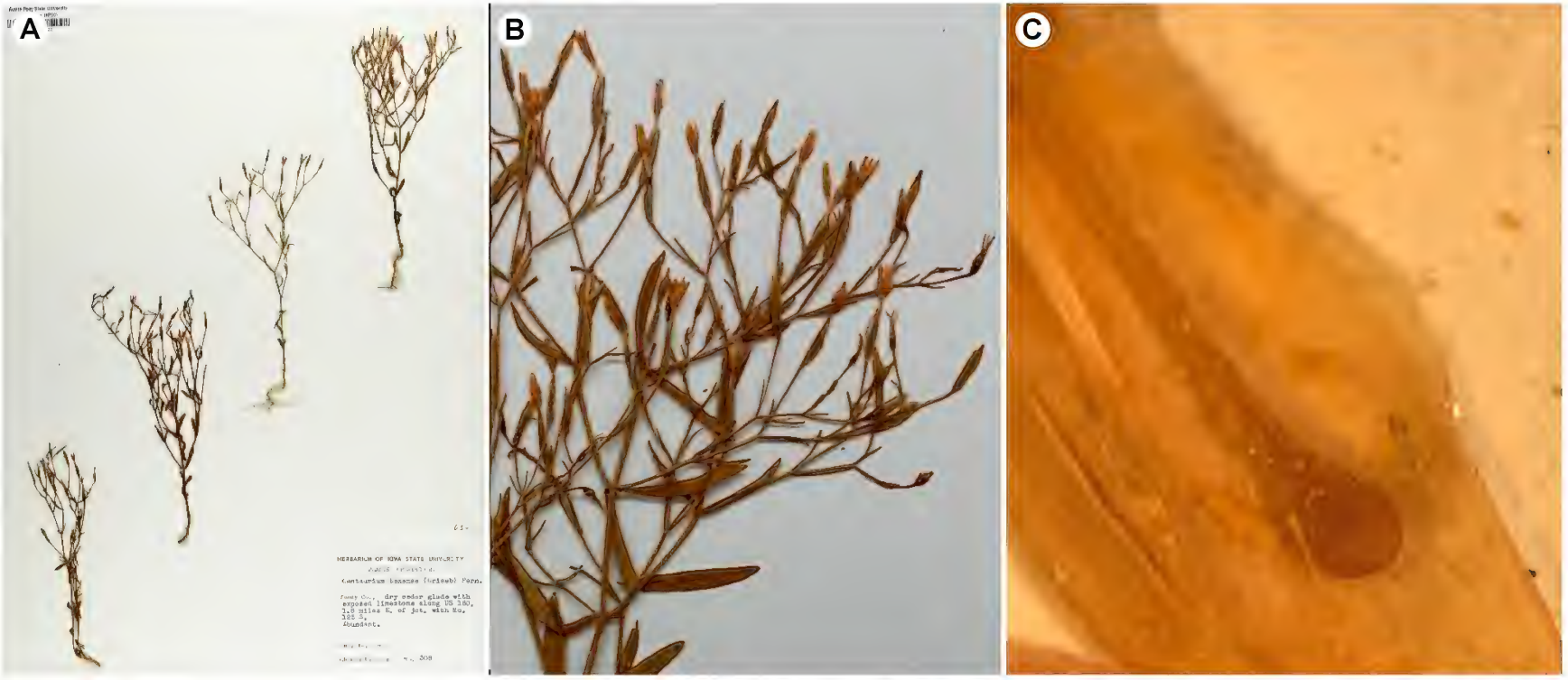

Figure 3. *Zeltnera texensis*. **A**. Habit (*Riggins 308*, APSC, from SERNEC). **B**. Pedicels (*Steyermark 22666*, MO). **C**. Stigma lobe and style (MO1809050). Photos: Caitlyn Sims.

Voucher specimens: **U.S.A. MISSOURI**: ST. LOUIS CO.: Litzsinger Road Ecology Center, fallow pipeline path east of Deer Creek, 38.624236°N, 90.376134°W, 9 June 2023, *C.M. Sims CMS 1107 with D.M. Deterding, C.A. Krutzsch, & K.C. Schmiedeler* (MO); Litzsinger Road Ecology Center, fallow pipeline path near woodland edge, east of Deer Creek, 38.625263°N, 90.37655°W, 27 July 2023, *C.M. Sims CMS1108* (MO).

Observations: **U.S.A. MISSOURI**: JEFFERSON CO.: High Ridge, 38.385663°N, 90.604209°W, 2020, *nyxchaos* (https://www.inaturalist.org/observations/53599853); ST. CHARLES CO.: Cottleville, 38.760938°N, 90.649577°W, 2021, *paulabetz* (https://www.inaturalist.org/observations/88719242).

Sesamum indicum

The first spontaneous population of *Sesamum indicum* in St. Louis County was discovered growing along Deer Creek at the LREC. There have been three other Missouri collections (as *S. orientale* L.), from Kansas City, Jefferson City, and St. Louis, with at least one from a wild population (St. Louis City: *Mühlenbach, 3181*, MO2432426; Mühlenbach 1979; Tropicos 2023). Two cultivated specimens were also collected from St. Louis City (Merello, 1781, 1998; Zarucchi, 2013; SERNEC 2023; Tropicos 2023), but they are not considered here. *Sesamum indicum*, or sesame, is an internationally used crop thought to be native to the Old-World tropics (Ashri 2007). None of the ca. 20 species in *Sesamum* L. are native to North America. However, *S. indicum* is a waif escaping cultivation (Weakley et al. 2023; Yatskievych 2013). Its distribution is sporadic throughout the eastern United States, Wisconsin, Texas, Louisiana, and California (Kartesz 2015).

Staff observed 20-30 plants growing on gravel bars along Deer Creek at the LREC in 2020 and 2021, with the first observation in July 2020 (Faupel & Rembert, pers. obs.). In September and October 2021, *Sesamum* was observed growing along the same gravel bars. This species occurred approximately 265 m (869 ft) downstream of the Metropolitan St. Louis Sewer District's pipeline construction site. An herbarium voucher was not created for this species at the LREC, but detailed picture evidence was uploaded to iNaturalist by James Faupel.

Observations: **U.S.A. MISSOURI**: ST. LOUIS CO.: Ladue, 38.625173°N, 90.377107°W, 2020, *arembert* (https://www.inaturalist.org/observations/54647347); Ladue, 38.625764°N, 90.377475°W, 2021, *aazmy* (https://www.inaturalist.org/observations/96679206); Ladue, 38.625713°N, 90.37758°W, 2021, *jfaupel* (https://www.inaturalist.org/observations/95402852); Ladue, 38.62587°N, 90.377752°W, 2021, *arembert* (https://www.inaturalist.org/observations/97447381).

Cyclospermum leptophyllum

One individual of *Cyclospermum leptophyllum* (marsh parsley) was discovered along Deer Creek in an overgrown lawn area undergoing reconstruction into native habitat. This is the second time that *C. leptophyllum* has been reported in Missouri. The first observation was in 2021 by Paul Winn, in Jefferson City. This species occurs in freshwater marshes, roadside ditches, and other

disturbed areas (Kartesz 2015; Weakley et al. 2023). Interestingly, *C. leptophyllum* has a primarily southern distribution including the Lower Mississippi River region, with the Kansas City area at the northernmost part of its midwestern range (Freeman & Morse 2019). *Cyclospermum* Lag. includes three species, with only one known from Missouri (Plunkett et al. 2018; Weakley et al. 2023). In Missouri, *Spermolepis* Raf. looks most similar to *C. leptophyllum*, but *Spermolepis* has tubercles or hairs on the mericarps while *C. leptophyllum* has smooth mericarps (**Figure 4**; Weakley et al. 2023; Yatskievych 2006). Successful identification requires examining the mericarps at 10× or higher magnification.

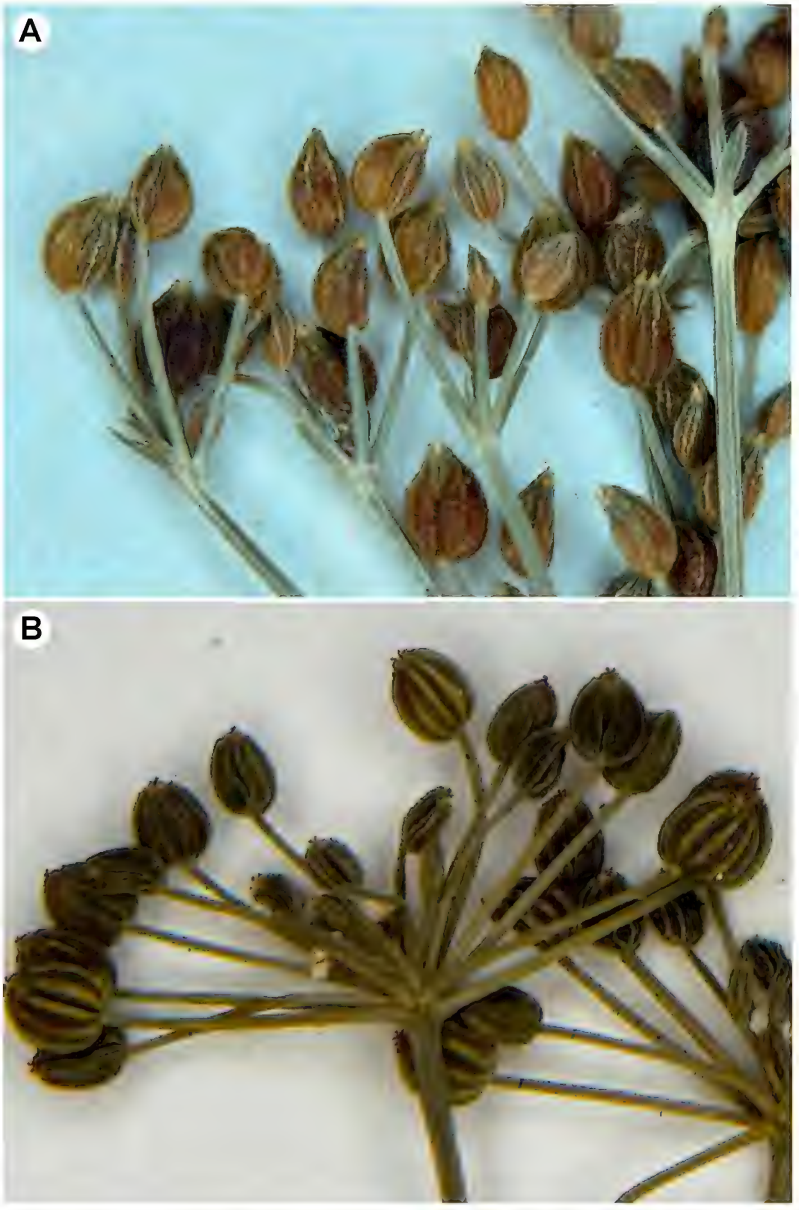

Figure 4. **A**. *Spermolepis inermis* fruits (*Reverechon 367*, MO). **B**. *Cyclospermum leptophyllum* fruits (*Stimson 157*, MO). Photos: James Faupel.

Voucher specimen: **U.S.A. MISSOURI**: ST. LOUIS CO.: Litzsinger Road Ecology Center, weedy, former lawn area near Deer Creek, adjacent to pipeline path, 38.622834°N, 90.375446°W, 11 May 2023, *C. M. Sims CMS1109* (MO).

Observation: **U.S.A. MISSOURI**: COLE CO.: Jefferson City, 38.588741°N, 92.231215°W, 2021, *pwinn47* (https://www.inaturalist.org/observations/85698128).

Krigia cespitosa

Krigia cespitosa (opposite-leaved dwarf dandelion) is native to the Southeastern United States and occurs in disturbed habitats (Weakley et al. 2023). In Missouri, *K. cespitosa* predominantly occurs south of the Missouri River, but was recorded in St. Louis City by Viktor Mühlenbach in 1976 (3939, MO3526935, Tropicos 2023) and in Franklin County by Nels Holmberg in 2012 (4287, MO6469567, Tropicos 2023), so it is possible its existence in St. Louis County has been previously overlooked. At the LREC, one individual was found in an overgrown lawn area next to Deer Creek. *Krigia cespitosa* is identified by unkeeled, erect phyllaries in fruit, achenes lacking a pappus, and branching stem leaves (Weakley et al. 2023; Yatskievych 2006). Of the five species of *Krigia* in Missouri, *K. cespitosa* is most morphologically similar to *K. occidentalis* Nutt. However, *K. occidentalis* has basal leaves only and a more western distribution (Kim & Turner 1992).

Voucher specimen: **U.S.A. MISSOURI**: ST. LOUIS CO.: Litzsinger Road Ecology Center, southern section of the pipeline path, parallel to gravel driveway, former lawn area near Deer Creek. 38.62283°N, 90.375687°W, 8 June 2023, *C.M. Sims CMS1105 with S.B. Killmer* (MO).

DISCUSSION

Although it is impossible to know with certainty how these species arrived in St. Louis County, I suspect they have been recently introduced at the LREC in one of three ways: (1) propagules in the soil added to the pipeline path, (2) fluvially via Deer Creek and its proximity to two major rivers, or (3) introduction via construction machinery.

In 2022, significant rainfall caused flash floods on Deer Creek, stripping away the first soil layer shortly after construction ended. Imported soil was then deposited by contractors in the eastern and southern sections of the pipeline path where the *C. pulchellum* specimen was later discovered. This soil had been harvested from the Missouri River floodplain bottomlands in Chesterfield, Missouri. The known western distribution of *C. pulchellum* includes Nebraska, South Dakota, Wyoming, and Colorado, which encompass the Upper Missouri River watershed (Kartesz 2015). Considering the western distribution of *C. pulchellum*, the imported soil from Chesterfield potentially introduced propagules to the LREC. *Centaurium pulchellum* also occurred in northern sections of the pipeline path where the Missouri River bottomland soil was not deposited, but Project Clear construction continued upstream of the LREC along Deer Creek, and presumably imported soil from the same supplier at those sites as well.

It is possible that Deer Creek has deposited these species at the LREC. With a large area of disturbed ground exposed after pipeline construction, these weedy species can now occupy areas where they could not before. For example, *M. arvensis* has a facultative wetland status (FAC) and a distribution that is western and northeastern in the Missouri, Mississippi, and Illinois River watersheds (Kartesz 2015; U.S. Army Corps of Engineers 2020). These rivers are passages for migratory shorebirds which serve as vectors for plant propagule dispersion (Green et al. 2002; Smith 1996). Deer Creek at the LREC is approximately 15 km (10 mi) south of the nearest bend of the Missouri River and west of the Mississippi River (Google Earth Pro 7.3.6.9345 2023). Although the two bodies are not physically connected, it is possible traveling water birds dispersed the seeds of *M. arvensis* between streams (Farmer et al. 2017; Kleyheeg & van Leeuwen 2015). The LREC is a part of the Mississippi Flyway, and many species of shorebirds and waterfowl visit annually during spring and fall migration.

The Metropolitan St. Louis Sewer District works throughout the St. Louis metropolitan area, so it is possible that propagules were retained on vehicles and machinery from different Project Clear sites. The pipeline construction project required use of large machinery and vehicles such as trucks, trenchers, backhoes, dump trucks, front loaders, and bulldozers. The pipeline path was occupied for three years with machines that are capable of dispersing seeds as far as 250 km between sites (Taylor et al. 2012). Gravel was also imported to the LREC at the Deer Creek crossings for machinery to traverse the entire pipeline pathway. It is unknown where the imported gravel came from, and it was washed downstream by flooding several times during the construction period (Faupel, pers. obs.). Presumably, gravel was imported by contractors at upstream Project Clear construction creek crossings as well. It is possible that *S. indicum* came from the upstream construction or residential areas. Regardless, this annual plant appears to be transient at the LREC and has not been recorded on site since construction ceased.

Although four out of the five species records are introduced to Missouri, they do not appear to pose a threat to Missouri's natural communities since they favor disturbed habitats and were found in small numbers. Several of these species are diminutive, easily overlooked, and are easily misidentified. Additional populations of these species may occur in Missouri and St. Louis County, so surveying construction zones, floodplains, and roadsides may yield new discoveries.

ACKNOWLEDGEMENTS

Thanks to two anonymous reviewers for their edits, comments, and suggestions. I would also like to thank James Faupel and Deanna Deterding for additional edits and comments. I thank all who helped survey plants at the LREC: James Faupel, Adam Rembert, Deanna Deterding, Allison Azmy, Cicely Krutzsch, Karen Schmiedeler, and Seth Killmer. Thank you to the iNaturalist community scientists for their observations and identification assistance, with special thanks to Ryan McDaniel and Douglas Goldman for discussion of the *C. pulchellum* and *M. arvensis* specimens. I thank the following herbaria for providing and maintaining specimens: Austin Peay State University (APSC) and Missouri Botanical Garden (MO). Special thanks to the collectors and those involved of the creation of the herbarium specimens.

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Phellodendron amurense has escaped cultivation in Missouri

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EVAN PARKER[4], AND MICHAEL SAXTON[5]

ABSTRACT. — Six populations of *Phellodendron amurense*, Amur cork tree, are reported from five sites in the St. Louis metropolitan region. We discuss the spread and establishment of this species in Missouri and evaluate ecological traits enabling its potential invasion of woodlands.

INTRODUCTION

Phellodendron amurense Rupr. (Rutaceae), Amur cork tree, is a deciduous tree native to mixed forests in Northeastern China, Japan, Korea, and Far Eastern Russia (**Figure 1**; Ma et al. 2006; Li et al. 2019), where it is valued for its medicinal properties and rot-resistant wood. The native distribution of *P. amurense* is constrained by minimum annual temperatures and summer precipitation (Zhang et al. 2023; Zhu et al. 2018). Amur cork tree commonly occurs in low-altitude habitats with low soil nitrogen and high soil organic matter (Huang et al. 2017). While studies from its native range show a preference for high-light conditions (Zhang et al. 2023; Yoshida & Kamitani 1999), *P. amurense* seedlings in a New York-based study showed tolerance for low-light conditions (Wang et al. 2013). The distribution of *P. amurense* has contracted in China due to over-harvesting for timber and medicinal uses (Zhang et al. 2016).

Phellodendron amurense was introduced to North America as a horticultural tree in 1856 (Rehder 1940, Dirr 1998), with early cultivations at the Arnold Arboretum in Boston, Massachusetts. By 1910 it was planted more extensively, including in Maryland and New York (Ma & Brach 2007). Early nursery catalogs and publications (e.g., Elm City Nursery 1905, Missouri Botanical Garden 1921, Rehder 1940) highlight *Phellodendron* for its vibrant fall foliage, conspicuous winter fruit, cold tolerance, and elegantly spreading crown. As late as 1994, the United States Forest Service recommended planting male *P. amurense* in median strips and residential areas, although warning of its inability to thrive in some urban environments (Gilman & Watson 1994). Through the 20th century, cork tree became more common in North American botanical gardens and arboretums and was planted in 20 states by 2007 (Ma & Brach 2007).

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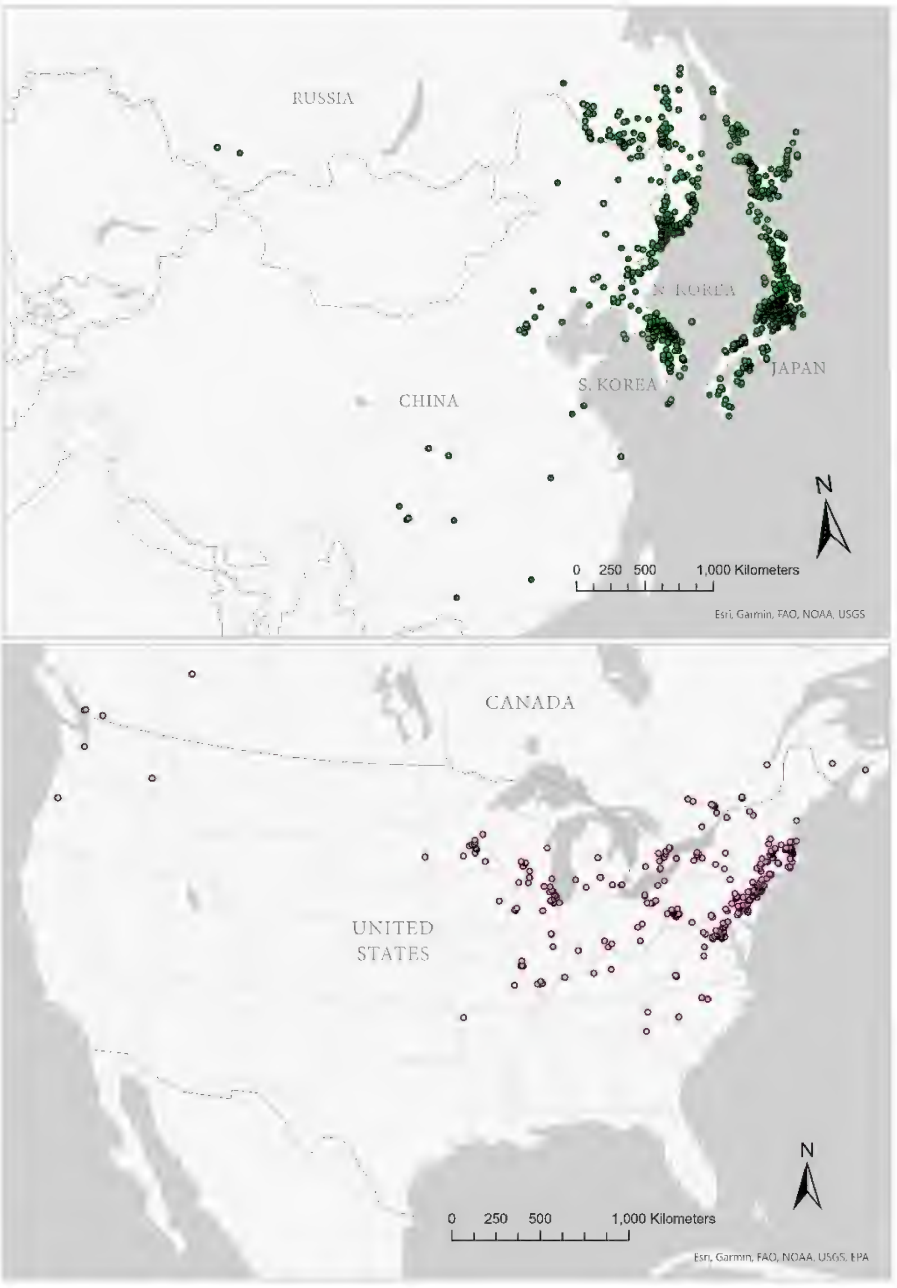

Figure 1. Native range of *P. amurense* in Asia (top) and introduced range in North America (bottom), based on records from the Global Biodiversity Information Facility (GBIF 2023).

Since its introduction to North America, Amur cork tree has escaped into urban parks, residential areas, and native forests from Nova Scotia to British Columbia, south to South Carolina and Arkansas. There are 983 Global Biodiversity Information Facility (GBIF) records in North America (**Figure 1**), and 1,776 iNaturalist observations in the United States (GBIF 2023; iNaturalist 2023); note that these records likely include horticultural plantings).

To date, *Phellodendron amurense* has spread primarily in the northeastern United States. Morgan and Borysiewicz (2012) documented the spread of *P. amurense* across New York, Connecticut, New Jersey, and Philadelphia, including at Forest Park in Queens County, New York, where *P. amurense* ranked third of 22 tree species in overall importance value (Gleaser & Kincaid 2005). Similarly, in Bartlett Arboretum Forest, Fairfield County, Connecticut, *P. amurense* ranked highest in relative density and third highest in relative dominance (Morgan 2012). These results indicate the ecological importance and potential impacts of *P. amurense* and highlight the need for broader surveys and documentation.

The history of *Phellodendron* in Missouri begins with cultivated specimens at the Missouri Botanical Garden (MBG), with first mention of *P. amurense* in 1921, where it was recommended for street planting in Missouri, as well as cataloged in a list of trees that suffered frost damage the previous winter (Missouri Botanical Garden 1921). Fruit vouchers of *P. amurense* document its cultivation at the University of Missouri Campus in Columbia, Boone County in 1960 and at the Missouri Botanical Garden in St. Louis City in 1974 and 1989 (Ma & Brach 2007). *P. amurense* has been planted in several additional St. Louis County locations: Forest Park (Amy Witt, personal communication), Tower Grove Park (Joseph Hart, personal communication), and on Washington University's Danforth Campus (trees.wustl.edu; Stan Braude and Cody Azotea, personal communication).

Despite a history of spreading in the northeastern United States, and more than a century after its introduction in Missouri, *Phellodendron amurense* has not been formally documented growing outside cultivation in Missouri. Yatskievych (2013) mentioned two small populations of *P. amurense* growing in the understory at Shaw Nature Reserve in Franklin County and at Forest Park in Saint Louis City, but did not include *P. amurense* as a member of the state's flora. Both populations mentioned were non-reproductive seedlings near adult plantings and under active control. The Early Detection and Distribution Mapping System (eddmaps.org), which tracks the spread of invasive species, reports *P. amurense* in Missouri based on a cultivated occurrence in Forest Park reported in 2012, likely the one referenced in Yatskievych (2013), as well as two naturalized occurrences in Shaw Nature Reserve reported in 2016. Here, we document Amur cork tree's spread and establishment in Missouri.

MISSOURI REPORTS

In addition to the three specimens cited below, we have recently documented six naturalized populations of *P. amurense* at five sites in the St. Louis region (**Figure 2**): 1) Forest Park, St. Louis City; 2) Tyson Research Center, St. Louis Co.; 3) Rockwoods Reservation and Range, St. Louis Co.; 4) Litzsinger Road Ecology Center, St. Louis Co.; 5) Shaw Nature Reserve, Franklin Co. Given its prevalence in these areas, *P. amurense* is likely present at more sites throughout the Saint Louis region and eastern Missouri.

Figure 2. Distribution of *P. amurense* in the St. Louis metropolitan area.

Forest Park: Forest Park is managed by the St. Louis Department of Parks, Recreation and Forestry, and Forest Park Forever. Since 1998, staff have monitored a self-sustaining population of *P. amurense* in the Successional Forest, an area of former park turf which has undergone succession for over 30 years. The Forest is bordered by areas of semi-natural and landscaped parkland within an urban environment.

The surrounding parkland contains 17 cultivated *P. amurense* individuals, ranging from 1.0–19.3 cm DBH. The wild *Phellodendron amurense* population occurs in a 32,000 m^2 area south of the east-west hiking trail bisecting the Successional Forest (**Figure 3**). In 1998, five cork trees ranging from 5.3 cm to 23.7 cm DBH were documented here (Josh Wibbenmeyer and Amy Witt, personal communication). By 2013, two of the original cork trees remained and three new cork trees were present. All mature trees were eliminated during restoration efforts in 2014-2015, and seedlings have been removed annually since then. In 2023, we counted 222 seedlings (height >20 cm) and 17 saplings (diameter >1 cm DBH), with the largest saplings 3.0 cm DBH. Saplings exclusively occurred in the higher-elevation, eastern side of the site. Seedlings occurred across the site, with the highest abundance near the creek on the site's western edge.

Other tree species occurring in this area were maples (*Acer negundo*, *A. saccharinum*), oaks (*Quercus acutissima*, *Q. alba*, *Q. imbricaria*, *Q. muehlenbergii*, *Q. rubra*), elms (*Ulmus sp.*), white ash (*Fraxinus americana*), black walnut (*Juglans nigra*), sycamore (*Platinus occidentalis*), common hackberry (*Celtis occidentalis*), sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), mulberry (*Morus sp.*), black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), basswood (*Tilia americana*), blackhaw (*Viburnum prunifolium*), Eastern redbud (*Cercis canadensis*), black locust (*Robinia pseudoaccacia*), and *Catalpa sp.*

Since 2014, *Phellodendron amurense* saplings have been cut and treated with glyphosate, or treated with a hand swipe basal bark triclopyr application. Staff have also controlled seedings with prescribed fire in March 2019 and January 2021, with future burns planned. Despite years of removal, we document a population of *P. amurense* which is persisting over time. While there are no fruiting trees in the Successional Forest, bird-mediated dispersal from the mature planted trees in Forest Park could be sustaining this population.

Shaw Nature Reserve: Established in 1925 and subsequently developed as an arboretum, numerous species were planted and propagated at the site through the late 1950s. The site was renamed Shaw Nature Reserve in 2000, with a focus on native species and ecological restoration (Missouri Botanical Garden 2001). In 2008, Nature Reserve staff discovered a grove of *Phellodendron amurense* in a former nursery site (**Figure 3**). The trees were felled and the ~60 cm diameter stumps treated with herbicide (Glenn Beffa, personal communication). In 2016, several dozen saplings were mowed but not treated with herbicide. Currently, the area harbors dozens of ca. 8 cm diameter saplings; a ca. 47-year-old non-fruiting tree (presumably male), and a fruiting ca. 14-year-old tree were both recently felled and stump treated with herbicide. *P. amurense* seedlings have been found at the Nature Reserve up to 1.8 miles (2.9 km) from this population (vouchers cited below; **Figure 4**).

Tyson Research Center: A 2,000-acre environmental field station of Washington University in St. Louis, this site consists primarily of secondary oak-hickory forest on the northern edge of the Ozarks Ecoregion. Within Tyson is a 50-acre long-term research site that is part of the Smithsonian Forest Global Earth Observatory network (ForestGEO; forestgeo.si.edu). Three individuals of *Phellodendron amurense* were observed in the ForestGEO plot in 2023 (**Figure 3**; iNaturalist observation 178696769), occurring on gentle, northeast-facing slopes. The largest individual was 30.1 cm DBH, and coring aged it to about 36 years, indicating a fast average growth rate of 0.8 cm/year. The largest tree is a reproductive female that was observed fruiting in October 2023; no seedlings were found. Although only three individuals were found, it is possible that more were present and previously misidentified.

Here, *Phellodendron* grows under a canopy of red and white oak (*Quercus rubra* and *Q. alba*), shagbark and pignut hickory (*Carya ovata* and *C. glabra*), and white ash (*Fraxinus americana*). Other understory species include flowering dogwood (*Cornus florida*), Carolina buckthorn (*Frangula caroliniana*), pawpaw (*Asimina triloba*), spicebush (*Lindera benzoin*), tree-of-heaven (*Ailanthus altissima*), and bush honeysuckle (*Lonicera maackii*).

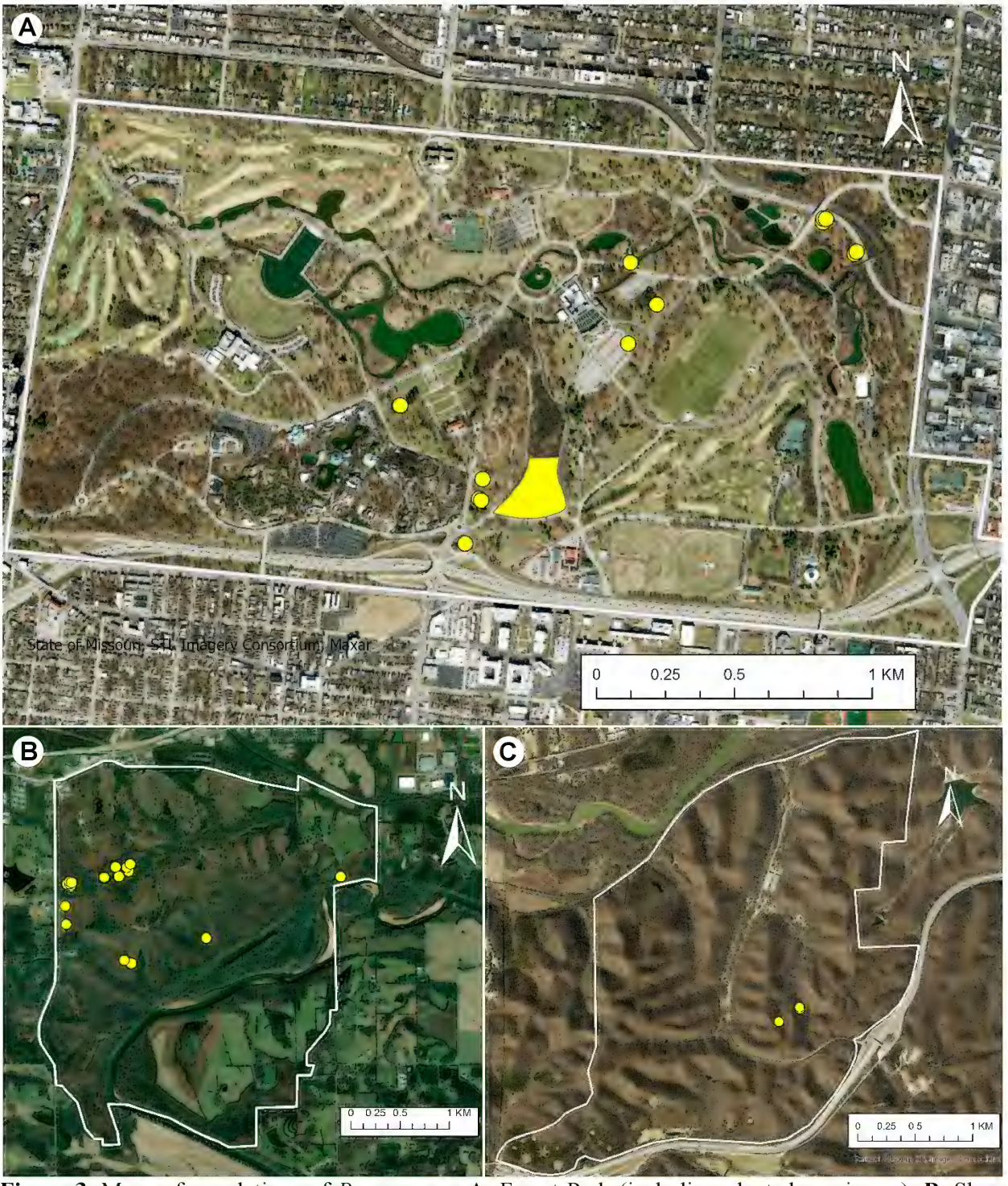

Figure 3. Maps of populations of *P. amurense*. **A**. Forest Park (including planted specimens). **B**. Shaw Nature Reserve. **C**. Tyson Research Center.

Rockwoods Reservation and Range: These areas are multiuse public lands managed by the Missouri Department of Conservation. Land managers have been removing *P. amurense* at Rockwoods Reservation since its discovery there in 2016 (Ben Davis, personal communication). The population is on the west side of the property, near Highway 100, and consists of scattered and sparse individuals that are removed when noted, with around a dozen total individuals removed to date. At Rockwoods Range, *P. amurense* was discovered in 2020, and managers have removed around two dozen individuals there, primarily near Six Flags and in the northwest corner of Rockwoods Range.

Litzsinger Road Ecology Center: Part of the Missouri Botanical Garden, Litzsinger Road Ecology Center (LREC) is 39 acres of creek, planted tallgrass prairie, and woodland. A few (<5) ca. 4-5 year old saplings of *P. amurense* were documented at LREC in 2021 and 2022 (James Faupel, personal communication). All plants were cut and herbicided upon discovery. There are no known cultivated or reproductive individuals at the site. Since the occurrences were all in regularly flooded riparian habitats associated with Deer Creek, a tributary of River Des Peres, it is likely that seeds washed in from an upstream source during flooding. Woody associates here include box elder (*Acer negundo*), Ohio buckeye (*Aesculus glabra*), common hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), and slippery elm (*Ulmus rubra*), under a canopy of American sycamore (*Platinus occidentalis*) and eastern cottonwood (*Populus deltoides*).

Voucher specimens: **U.S.A. MISSOURI**: FRANKLIN CO.: Shaw Nature Reserve, Brush Creek drainage, 8-10 young, single-stemmed individuals to 12 ft tall, scattered on semi-shaded gravel bars of creek, 37.6538800°N, 90.8494400°W, 29 September 2008, *Beffa s.n.* (MO 6087252). Shaw Nature Reserve, West of Wild Flower Trail, semi-shaded gravelly soil in woodland, 21 April 2016; *Megan Engelhardt 183 with James C. Trager* (MO 7023243). SAINT LOUIS CO.: Litzsinger Road Ecology Center, South Woods, along Deer Creek, one individual ca. 6 ft tall, 38.6236111°N, 90.3769444°W, 7 July 2022, *Owen Kathriner 34* (MO).

Observations: **U.S.A. MISSOURI**: ST. LOUIS: Litzsinger Road Ecology Center, 8 October 2021, *Allison Azmy*. iNaturalist observation: www.inaturalist.org/observations/97557582. Washington University Tyson Research Center, 16 August 2023, *Zo Benz*. iNaturalist observation: http://www.inaturalist.org/observations/178696769.

A
MISSOURI BOTANICAL GARDEN HERBARIUM
№ 6087252
FLANTS OF MISSOURI, U.S.A.
RUTACEAE
Phellodendron amurense Rupr.
FRANKLIN COUNTY: Shaw Nature Reserve, Grey Summit; Brush Creek Drainage; 8–10 young, single-stemmed individuals to 12 ft tall, scattered on semi-shaded gravel bars of creek; bruised or broken branches emit a strong, sweet, pungent odor. T34N R02E S17; elevation 580 ft.
29 September 2008
Glenn Beffa s n.
EXAMINED FOR THE FLORA OF MISSOURI PROJECT
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)
B
MISSOURI BOTANICAL GARDEN HERBARIUM
№ 7023243
UNITED STATES
RUTACEAE
Phellodendron amurense Rupr.
Missouri: Franklin County
Megan Engelhardt & James T.
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Figure 4. Missouri Botanical Garden herbarium vouchers collected at Shaw Nature Reserve in 2008 by Glenn Beffa (**A**) and in 2016 by Megan Engelhardt and James Trager (**B**).

IDENTIFICATION AND TAXONOMY

Phellodendron amurense is easily recognized by its thick corky bark, bright yellow cambium, and distinctive citrus-skunk odor of the crushed leaves. It has deciduous, opposite, odd-pinnate compound leaves that turn yellow in autumn. Leaflets number 5-13 per leaf and have undulate, entire margins. Amur cork tree is dioecious, with panicles of small yellow-green flowers blooming late May to early June. Fruits are small dark drupes (0.6-1.3 cm) maturing in late October and remaining on the tree into winter. Buds are naked, with the top lateral bud pair offset slightly below the terminal bud. Lateral buds are enclosed by the petiole bases. (**Figure 5**; Rehder 1940; Gilman & Watson 1994; Simons 2006; Ma & Brach 2007).

Locally, several species can resemble *Phellodendron amurense*. In Yatskievych (2013), it would key to *Tetradium daniellii* (Benn.) T.G. Hartley, another Asian tree in the Rutaceae which lacks the corky bark and does not have the axillary buds concealed in the petiole bases. *Phellodendron amurense* can be differentiated from similar compound-leaved plants by its turpentine smell and the bright yellow inner bark. Ashes (*Fraxinus* spp.) have serrate leaflets and exposed axillary buds. Tree-of-heaven (*Ailanthus altissima*) has alternate leaves and leaflets typically with a small basal lobe and a foul, peanut-like odor. Elderberry (*Sambucus spp.*) can be differentiated by its scaled buds and serrate leaflets.

DISCUSSION

While the *Phellodendron amurense* populations at Forest Park and Shaw Nature Reserve likely originated from cultivated trees onsite, the other populations reported here (Rockwoods Reservation and Range, Tyson Research Center, and Litzsinger Road Ecology Center) have no records of *P. amurense* plantings. Its presence in those locations document dispersal to and naturalization in native ecosystems. All populations documented here are in sites with active management and/or research activities, and we expect that *P. amurense* is also spreading undetected into non-managed areas. The species can thrive in a variety of plant communities as demonstrated by the diverse range of habitats reported here, from floodplain to oak-hickory forest to city park. This contrasts with reports that it requires full sun in its native habitat (Yoshida & Kamitani 1999). However, it is consistent with the site description of the New York City population in a disturbed mesic site with both open sun and dense shade (Gleaser & Kincaid 2005, Morgan 2012).

The success of *Phellodendron amurense* as an invasive species is likely due to life history traits enabling it to spread and establish quickly. Seeds are bird and fluvially dispersed, resulting in a wide dispersal range (Ning & Dafang 1990; James Faupel, personal observation). Amur cork tree is capable of immediate colonization (Morgan & Boryiewicz 2012), and seeds can remain viable for several years (Simmons 2006). Once germinated, *P. amurense* forms dense seedling layers that shade the understory and persist until an opportunistic opening in the canopy enables their release (Morgan 2012). With greater light access, *P. amurense* can grow quickly in its early years, attaining heights of 10-12 feet in 5-8 years (Simons 2006). This is consistent with our

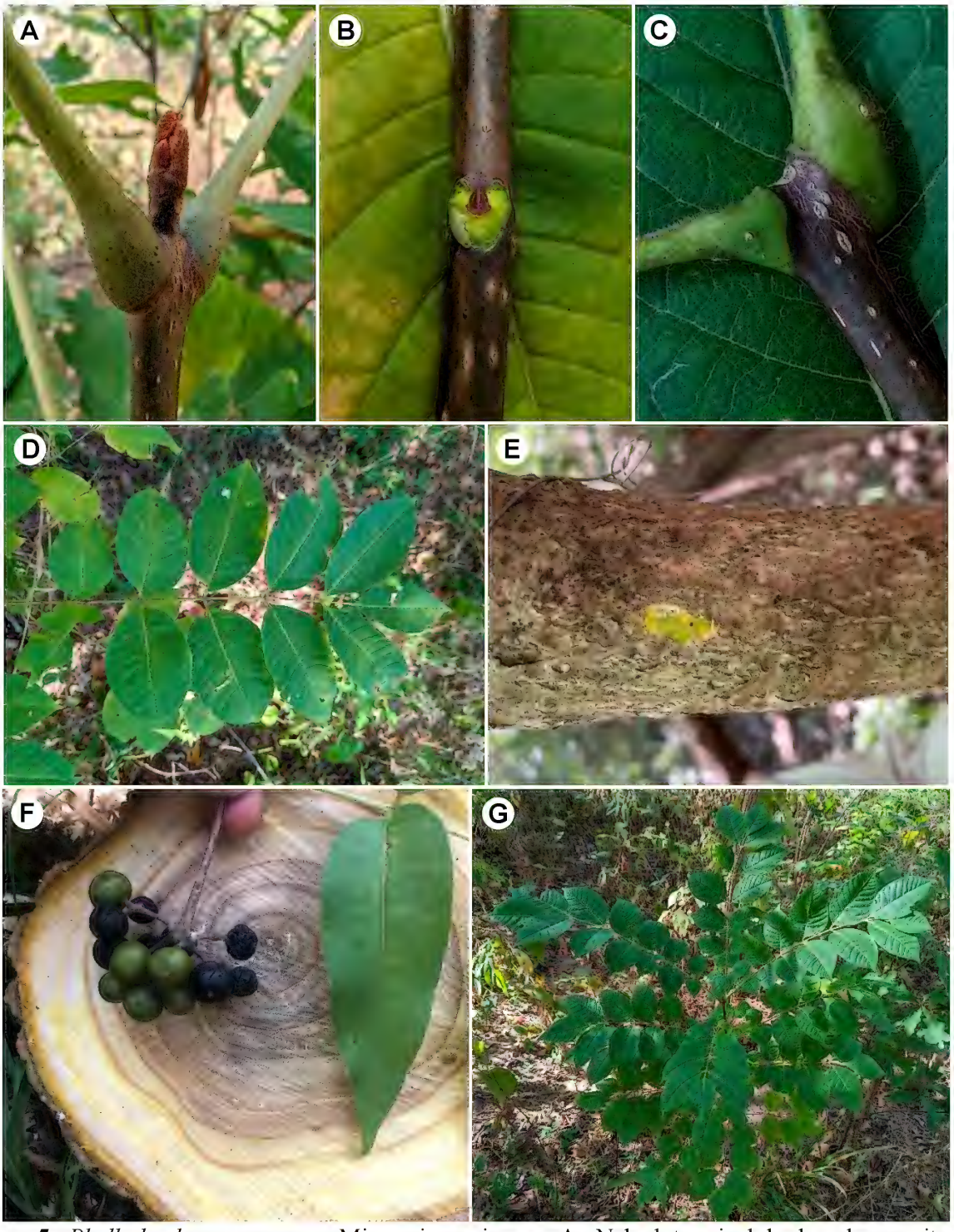

Figure 5. *Phellodendron amurense,* Missouri specimens. **A**. Naked terminal bud and opposite leaf arrangement. **B**. Lateral bud enclosed by leaf scar. **C**. Stem lacking terminal bud. **D**. Compound leaf with 11 leaflets. **E**. Corky bark with neon yellow underneath. **F**. Fruits in panicle arrangement, with trunk cross section. **G**. Seedling. Photos: Erin O'Connell (A-D, G), Zo Benz (E), and Mike Saxton (F).

observations at Tyson Research Center. Furthermore, allelopathy has been documented in *P. amurense*; while this impedes germination and seedling development of *P. amurense* in its native range (Zhang et al. 2011, Wang et al. 2013), it may also provide a competitive advantage in its introduced range. Morgan (2012) reports no signs of deer herbivory on *P. amurense*, suggesting that cork tree may be escaping herbivory pressures experienced by its native counterparts.

Cork tree's adaptation to diverse habitats and suite of invasive-linked life history traits could lead to continued spread in Missouri and elsewhere. Niche modeling predicts that the northern United States, southern Canada, southern Russia, and Kazakhstan provide the most potential area for non-native range expansion of *P. amurense* (Li et al. 2019). However, this suitable range area notably excludes Missouri. This suggests that the wild-growing individuals reported here occur at the southern extreme of their potential North American range or could indicate that *P. amurense* is experiencing competitive release in its non-native range, allowing it to expand beyond its native climatic conditions. Gilman and Watson (1994) suggest that *P. amurense* could survive as far south as USDA Hardiness Zone 8, which includes central Texas and northern Florida.

We warn of *P. amurense's* ability as a woody invasive plant species to threaten native forest ecosystems. Ma and Brach (2007) argue against classifying *P. amurense* as invasive, since escaped populations have primarily established in urban and residential areas rather than native ecosystems. However, four of our reported populations are in rural natural areas, in direct contrast to Ma and Brach's assertion. Additionally, the population in Forest Park has persisted despite nearly a decade of active restoration and control efforts, and the abundance of seedlings documented there portends a continued invasion threat. Our reports align with several case studies in the northeastern United States categorizing *P. amurense* as an invasive risk. In both New York City and Fairfield County, Connecticut, *P. amurense* ranked among the top three tree species for metrics of ecological dominance (Glaeser & Kincaid 2005, Morgan 2012).

Phellodendron amurense currently appears on a number of state invasive species lists. The Midwest Invasive Plants Network (mipn.org/plantlist) reports *P. amurense* as invasive in six states and the Early Detection and Distribution Mapping System (eddmaps.org) reports *P. amurense* from nineteen states; both lists include Missouri (**Table 1**). However, Missouri is excluded from the Center for Invasive Species and Ecosystem Health (invasives.org) list of 12 states and the Invasive Plant Atlas of the United States (invasiveplantatlas.org) list of three states. Likewise, the Missouri Invasive Plant Council (moinvasives.org) omits *P. amurense*. Based on the established Missouri populations documented here, we call for inclusion of *P. amurense* in Missouri invasive species lists and for more tracking of *P. amurense*.

Our reports of *P. amurense* populations at five sites in the St. Louis metropolitan region, including three sites with no Amur cork tree plantings, confirm the escape of *P. amurense* from cultivation. Given its history of spread in northeastern United States and life history traits contributing to invasion success, we warn of its potential threat to native Missouri ecosystems.

Table 1. States where *P. amurense* is listed as invasive.

State	EDD Maps (no. of reports)	Center for Invasive Species and Ecosystem Health	Midwest Invasive Plant Lists	Invasive Plant Atlas
Colorado	1	-	-	-
Connecticut	10	-	-	-
Delaware	1	-	-	-
Illinois	11	-	-	-
Indiana	19	listed	prohibited and listed	-
Kentucky	1	listed	-	watch list
Maine	-	law	-	-
Maryland	6	listed and law	-	-
Massachusetts	27	law	-	-
Michigan	-	-	listed	-
Minnesota	155	law	listed	-
Missouri	**3**	-	**listed**	-
New Hampshire	8	listed	-	-
New Jersey	32	listed	-	-
New York	89	law	-	-
Ohio	11	-	listed	-
Pennsylvania	13	listed	-	-
Rhode Island	3	listed	-	listed
Virginia	3	-	-	listed
West Virginia	1	-	-	-
Wisconsin	24	law	prohibited	-

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Another devil comes to town: *Pilosella aurantiaca* new to Missouri

DOUGLAS LADD[1] AND DEBORAH LADD[2]

ABSTRACT. — *Pilosella aurantiaca*, devil's paintbrush, is reported new to Missouri from a population in St. Louis County that has persisted and spread for at least two years.

INTRODUCTION

Pilosella aurantiaca (L.) F.W. Schultz & Schultz-Bip. (Asteraceae) [=*Hieracium aurantiacum* L.] is a scapose perennial with involucres of attractive orange ray flowers that is native to central and northern Europe, primarily in montane regions (Wilson & Callihan 1999). Commonly applied vernacular names for this species include devil's paintbrush, orange hawkweed, king devil, and fox-and-cubs.

According to Voss and Reznicek (2012), in the United States the species was planted as an ornamental in Vermont before 1875. It has subsequently spread and become widely distributed in the Northeast and Great Lakes regions, as well as in the northwestern states and Colorado Rockies, with outlying populations reported from as far south as Florida, Georgia, and Arkansas (USDA 2023). The species is classified as a noxious invasive in much of the western portion of its range in the United States (Kartesz 2015). It grows in a wide variety of habitats from wetlands and forests to lawns, roadsides, and old fields, and can become particularly abundant in sandy or rocky soils with low to moderate vascular competition. As an example of its ubiquity in northern regions, it is known from every county but one in the six New England states (Kartesz 2015, Native Plant Trust 2023).

Despite its early use as an ornamental in North America, by the mid-20th century Bailey (1949) noted its propensity to become a "bad weed," also observing that it was "probably no longer cultivated." Stone (2010) provides a comprehensive overview of the ecological, invasive impacts, and distributional status of the species in the United States, including discussion of allelopathy.

Although abundant in boreal regions, *Pilosella aurantiaca* is rare and sporadic in the southern portions of its range in the United States. The closest populations to Missouri include a record from Washington County, in northwestern Arkansas, ca. 29 miles south of the Missouri border [weed in lawn, 30 May 1977, *Richard Denton 19* (UARK 10377); digital image accessed

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via SERNEC (2023)]. This is the only record from the south-central states. Spyreas et al. (2017) list a record from Cole County, Illinois, ca. 125 miles east/northeast of the St. Louis area, but rank the report as medium confidence with no specimen information available. Eilers and Roosa (1994) report it as rare in Iowa, with records from three northeastern counties.

Species of *Pilosella* Hill. were traditionally included within *Hieracium* L., but based on their stoloniferous habit, pappus bristles in a single series, and projecting ribs at the fruit apices, as well as recent molecular data (e.g., Bräutigam & Greuter 2007, Kilian et al. 2009), there is growing recognition of *Pilosella* as a separate genus. Interestingly, the name *Pilosella* was first applied to two disparate groups of plants in the 16th century, when Leonhart Fuchs used it for species later included in *Hieracium*, and Johannes Thal applied it to what is now known as *Arabidopsis thaliana* (L.) Heynh. in the Brassicaceae (Rydberg 1907). Since Hill (1756) was the first post-Linnaean application of *Pilosella*, for a common British hawkweed, the name validly applies to *Hieracium* segregates.

In the Missouri flora, in addition to *Pilosella aurantiaca*, the adventive *Hieracium caespitosum* Dumort. would be included within *Pilosella* [as *P. caespitosa* (Dumort.) P.D. Sell & C. West]; the other three species, all native in Missouri — *H. gronovii* L., *H. longipilum* Torr., and *H. scabrum* Michx — would be retained within *Hieracium*.

Missouri Population

In May 2022, we found a small population of *Pilosella aurantiaca* growing in needle litter under a line of mature planted *Pinus strobus* on a sparsely vegetated roadside embankment in Webster Groves (**Figure 1**). The trees have been in place for at least 40 years, forming a visual screen between a commercial area to the east and residences on the west side of the road. We have regularly walked along this road for decades, but only noted the *Pilosella* in 2022, when there were three scattered stoloniferously spreading clumps and ca. four additional isolated individuals scattered along the embankment, in well-drained, rocky soil with pine needle humus. The plants were associated with a sparse weedy vegetation of *Galium pedemontanum*, *Lonicera maackii* seedlings, *Plantago lanceolata*, *Schedonorus pratensis* (Huds.) P. Beauv., *Sonchus asper*, and *Trifolium repens*. The population spanned ca. 10 meters along the shaded embankment.

The population expanded in 2023, with the original area containing more flowering scapes, and a few new individuals up to 5 meters beyond the area inhabited by the plants in 2022. The plants fruited in both 2022 and 2023. In 2023, we also noted plants in a sloping residential lawn on the west side of the road. The Missouri population may have originated from an adjacent overgrown garden bed at this residence, although the plants here appeared weedy and as noted above, the species is rarely if ever cultivated and is not commercially available. Given the abundance of the species in many recreational areas and campgrounds in northern regions, campers and vacationers could inadvertently spread seeds.

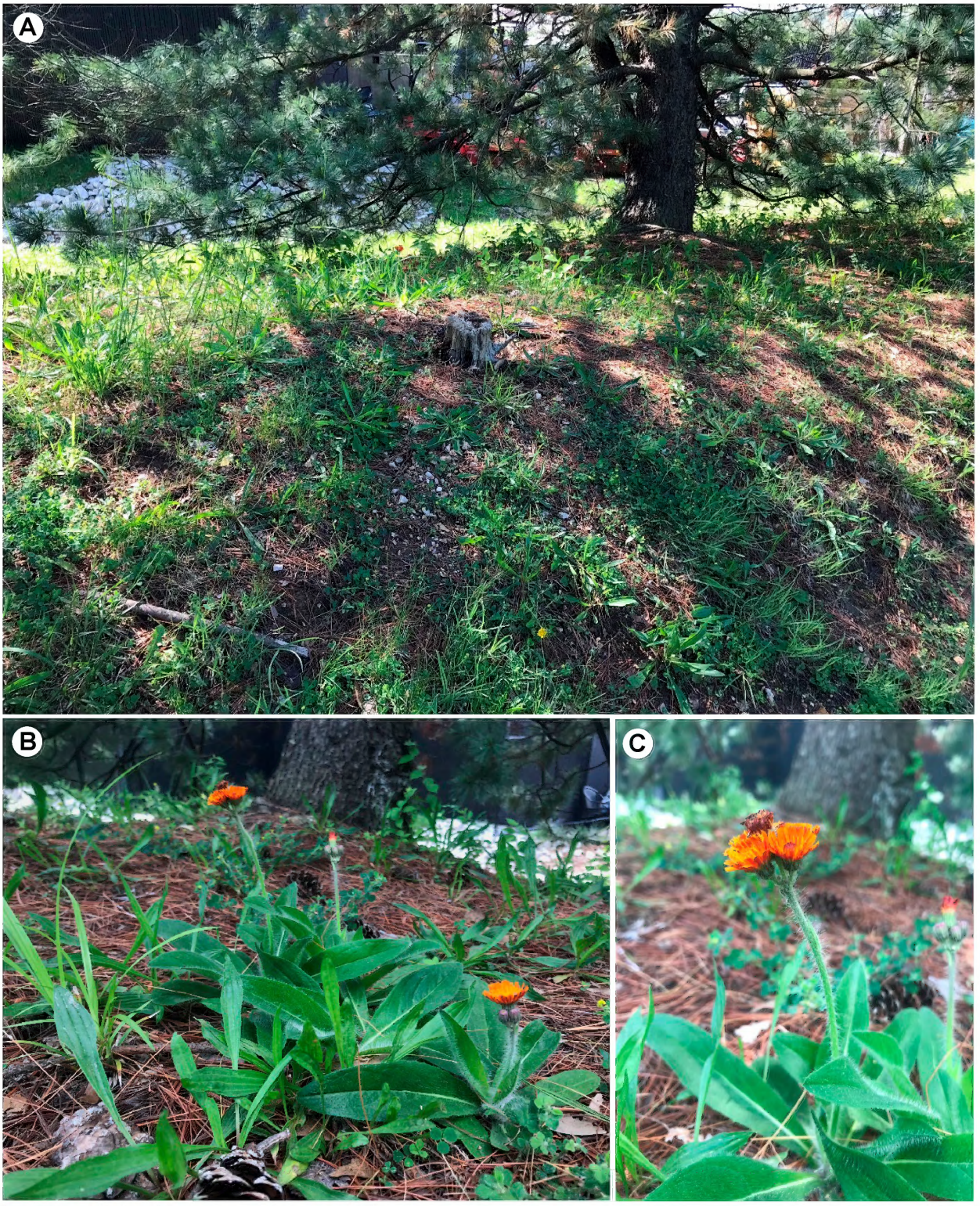

Figure 1. *Pilosella aurantiaca* at the Missouri site: **A**. Site image showing scattered basal rosettes. **B** and **C**. Flowering plants. Photos: Douglas Ladd, 22 May 2022.

With its milky sap, scapose habit, involucres of exclusively ligulate flowers, ± entire leaves, multiple flowering heads, and capillary white pappus bristles, *Pilosella aurantiaca* would readily key to *Hieracium* in Yatskievych (2006). Within his key to *Hieracium*, *P. aurantiaca* would key to *H. caespitosum* (=*P. caespitosa*), from which it reliably differs primarily in the orange ray flowers drying to dark or purplish red, versus the persistently yellow flowers of *H. caespitosum*.

Specimen cited: **U.S.A. MISSOURI**: ST. LOUIS CO.: City of Webster Groves, in SW part of city, along E side of West Old Watson Rd., just south of Wester Glen Court; weedy roadside embankment in needle litter under mature *Pinus strobus*, 38.56426°N, 90.36683°W, 22 May 2022, *Douglas Ladd 36805* (MO).

Summary

Despite its ubiquity in northern parts of the country, *Pilosella aurantiaca* seems to be a weakly competitive weed in southern regions, as evidenced by the rarity of records in non-montane areas in the southern half of the United States. It is likely to continue to expand both vegetatively and through wind-dispersed seeds at the Webster Groves location as long as the benign neglect of infrequent mowing and lack of plantings continue, and the pine allée remains to provide acidified needle humus and light shade. However, the species is extremely unlikely to become a problem from a conservation or management perspective. In its current setting it adds color and pollinator resources to an otherwise drab ruderal waste site. Although seed production in the species appears to be primarily apomictic (Koltunow et al. 1998), the flowers provide pollen and limited nectar for native pollinators in the United States (e.g., Heinrich 1976, Strickler et al. 1996).

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